

USSN 09/941,827

Response

1. (currently amended) A method of forming a dielectric layer, comprising the steps of:
annealing a polysilicon substrate in nitric oxide to form an oxide layer;
nitridizing the oxide layer to form ~~an~~ a nitride layer; and
depositing the dielectric layer onto the nitride layer.
2. (currently amended) A method of forming a dielectric layer, comprising the steps of:
annealing a polysilicon substrate in nitric oxide at a temperature of less than 800°C[[.]] to form an oxynitride layer;
nitridizing the oxynitride layer to form a nitride layer; and
depositing the dielectric layer onto the nitride layer.
3. (original) The method of Claim 2, wherein the step of annealing the polysilicon substrate is at a temperature of about 700 to about 750°C.
4. (original) The method of Claim 1, wherein the polysilicon layer comprises a polysilicon selected from the group consisting of doped polysilicon, undoped polysilicon, and HSG polysilicon.
5. (original) The method of Claim 1, wherein the oxynitride layer is about 40 angstroms or less.
6. (currently amended) The method of Claim 1, wherein the oxynitride layer is less than 15 angstroms thick.
7. (currently amended) A method of forming a dielectric layer, comprising the steps of:

USSN 09/941,827

Response

annealing a polysilicon substrate in nitric oxide at a temperature of less than 800°C[[.]] to form an oxynitride layer;

nitridizing the oxynitride layer to form a nitride layer by exposing the oxynitride layer to a nitrogen-containing gas; and

depositing the dielectric layer onto the nitride layer.

8. (original) The method of Claim 7, wherein the nitrogen-containing gas is selected from the group consisting of nitrogen, ammonia, nitrous oxide, and nitric oxide.

9. (original) The method of Claim 7, wherein the nitrogen-containing gas is selected from the group consisting of a plasma mixture of nitrogen and helium, and a plasma mixture of nitrogen and argon.

10. (original) The method of Claim 7, wherein the step of nitridizing comprises exposing the oxynitride layer to an active nitrogen-containing species formed in a plasma.

11. (original) The method of Claim 7, wherein the step of nitridizing the oxynitride layer is at a temperature of about 0 to about 900°C.

12. (original) The method of Claim 7, wherein the oxynitride layer and nitride layer have a combined thickness of about 10 to about 40 angstroms.

13. (original) A method of forming a dielectric layer, comprising the steps of:
annealing a polysilicon substrate in nitric oxide to form an oxynitride layer;
nitridizing the oxynitride layer to form a nitride layer; and
depositing a high K dielectric layer onto the nitride layer.

14. (original) The method of Claim 13, wherein the dielectric material is selected from the group consisting of tantalum pentoxide, titanium dioxide, barium strontium titanate,

USSN 09/941,827

Response

strontium titanate, barium titanate, lead zirconium titanate, strontium bismuth tantalate, hafnium oxide, zirconium oxide, and aluminum oxide.

15. (original) The method of Claim 13, wherein the dielectric layer comprises tantalum pentoxide.

16. (original) The method of Claim 13, further comprising, after the step of forming the dielectric layer, annealing the dielectric layer in an oxidizing gas.

17. (original) The method of Claim 16, wherein the oxidizing gas is selected from the group consisting of oxygen, plasma oxygen, ozone, nitrous oxide, and mixtures thereof.

18. (currently amended) A method of forming a dielectric layer, comprising the steps of:

annealing a polysilicon substrate in nitric oxide at a temperature less than 800°C[[.]] to form an oxynitride layer;

nitridizing the oxynitride layer in a nitrogen-containing gas to form a nitride layer;

depositing a high K dielectric layer onto the nitride layer; and

annealing the dielectric layer in an oxidizing ambient.

19. (original) The method of Claim 18, wherein the step of annealing the polysilicon substrate is at a temperature of about 700 to about 750°C.

20. (original) The method of Claim 18, wherein the oxynitride layer has a thickness that is substantially the same before and after the step of annealing the dielectric layer.

21. (original) The method of Claim 18, wherein the oxynitride is about 40 angstroms or less.

USSN 09/941,827

Response

22. (original) The method of Claim 18, wherein the oxynitride layer is less than 15 angstroms.

23. (original) A method of forming a dielectric layer on a semiconductor substrate, comprising the steps of:

annealing a polysilicon substrate in nitric oxide at a temperature of less than 800°C to form an oxide layer having a thickness of about 40 angstrom or less;
exposing the oxide layer to a nitrogen-containing gas to form a nitrided oxide layer; and
forming a high K dielectric layer over the nitrided oxide layer.

24. (original) A method of forming a dielectric layer on a semiconductor substrate, comprising the steps of:

annealing a polysilicon substrate in nitric oxide at a temperature of about less than 800°C to form an oxide layer having a thickness of about 40 angstroms or less;
exposing the oxide layer to a nitrogen-containing gas to form a nitrided oxide layer;
forming a high K dielectric layer over the nitrided oxide layer; and
annealing the dielectric layer in an oxidizing ambient;
whereby the thickness of the nitrided oxide layer after the step of annealing the dielectric layer is about 40 angstroms or less.

25. (previously presented) A method of forming a dielectric layer, comprising the steps of:

providing a polysilicon substrate;
heat treating the polysilicon substrate in nitric oxide to form a thin oxide layer over the polysilicon substrate;
exposing the oxide layer to a nitrogen-containing gas to form a nitride layer; and
forming a high K dielectric layer over the nitride layer.

26. (previously presented) A method of forming a dielectric layer, comprising the steps of:

MAD/112351.1

5 of 30

USSN 09/941,827

Response

providing a substrate comprising polysilicon;
forming an oxide layer over the polysilicon substrate by heat treating the polysilicon substrate in nitric oxide at a temperature of less than 800°C, such that nitrogen concentrates within the oxide layer at an interface between the oxide layer and the polysilicon substrate;
forming a nitride layer over the oxide layer by exposing the oxide layer to a nitrogen-containing gas; and
forming a high K dielectric layer over the nitride layer.

27. (currently amended) A method of forming a dielectric layer, comprising the steps of:

annealing a polysilicon substrate in nitric oxide at a temperature of less than 800°C[[.]] to form an oxynitride layer;

nitridizing the oxynitride layer to form a nitride layer by exposing the oxynitride layer to an activated nitrogen-containing gas to form a nitrided oxide layer; and

depositing the dielectric layer onto the nitrided oxide layer.

28. (original) The method of Claim 27, wherein the nitrogen-containing gas is selected from the group consisting of nitrogen, ammonia, nitrous oxide, and nitric oxide.

29. (original) The method of Claim 27, wherein the step of nitridizing comprises exposing the oxynitride layer to an active nitrogen-containing species formed in a plasma.

30. (original) The method of Claim 27, wherein the step of nitridizing the oxynitride layer is at a temperature of about 0 to about 900°C.

31. (original) The method of Claim 27, wherein the oxynitride layer and nitride layer have a combined thickness of about 10 to about 40 angstroms.

32. (original) A method of forming a dielectric layer, comprising the steps of:
annealing a polysilicon substrate in nitric oxide to form an oxynitride layer;

MAD/112351.1

6 of 30

USSN 09/941,827

Response

nitridizing the oxynitride layer in an activated nitrogen-containing gas to form a nitrided oxide layer; and

depositing a high K dielectric layer onto the nitride layer.

33. (currently amended) A method of forming a dielectric layer on a semiconductor substrate, comprising the steps of:

providing a substrate comprising HSG polysilicon;

annealing the polysilicon substrate in nitric oxide at a temperature of about 700°C[[.]] to about 750°C[[.]] to form an oxide layer having a thickness of about 40 angstroms or less;

exposing the oxide layer to a nitrogen-containing gas to form a nitrided oxide layer;

forming a layer comprising tantalum pentoxide over the nitrided oxide layer; and

annealing the tantalum pentoxide layer in an oxidizing ambient;

whereby the thickness of the nitrided oxide layer is about 40 angstroms or less.

34. (currently amended) A method of forming a dielectric layer on a semiconductor substrate, comprising the steps of:

providing a substrate comprising HSG polysilicon;

annealing the polysilicon substrate in nitric oxide at a temperature of about 700°C[[.]] to about 750°C[[.]] to form an oxide layer having a thickness of about 40 angstroms or less;

exposing the oxide layer to an activated nitrogen-containing gas to form a nitrided oxide layer;

forming a layer comprising tantalum pentoxide over the nitrided oxide layer; and

annealing the tantalum pentoxide layer in an oxidizing ambient;

whereby the thickness of the nitrided oxide layer is about 40 angstroms or less.

35. (currently amended) A method of forming a semiconductor device above a semiconducting substrate having a surface, comprising the steps of:

forming a nitrided oxynitride layer over a polysilicon substrate by annealing the polysilicon substrate in the presence of a nitric oxide at a temperature of about 700 to about 750°C[[.]] to form an oxynitride layer, and nitridizing the oxynitride layer in a nitrogen-

USSN 09/941,827

Response

containing gas; the nitrided oxynitride layer having a thickness of about 40 angstroms or less;
and

forming a dielectric layer over the nitrided oxynitride layer.

36. (original) The method of Claim 35, wherein the dielectric material comprises a high K dielectric.

37. (original) The method of Claim 36, wherein the dielectric material is selected from the group consisting of tantalum pentoxide, titanium dioxide, barium strontium titanate, strontium titanate, barium titanate, lead zirconium titanate, strontium bismuth tantalate, hafnium oxide, zirconium oxide, and aluminum oxide.

38. (original) The method of Claim 36, wherein the dielectric layer comprises tantalum pentoxide.

39. (original) The method of Claim 36, further comprising, after the step of forming the dielectric layer, annealing the dielectric layer in an oxidizing gas, wherein the thickness of the nitrided oxynitride layer is about 40 angstroms or less.

40. (original) The method of Claim 39, wherein the oxidizing gas is selected from the group consisting of oxygen, plasma oxygen, ozone, nitrous oxide, and mixtures thereof.

41. (currently amended) A method of forming a semiconductor device above a semiconducting substrate having a surface, comprising the steps of:

forming a nitrided oxynitride layer over a polysilicon substrate by annealing the polysilicon substrate in the presence of a nitric oxide at a temperature of about 700 to about 750°C[[.]] to form an oxynitride layer, and nitridizing the oxynitride layer in an activated nitrogen-containing gas; the nitrided oxynitride layer having a thickness of about 40 angstroms or less; and

forming a dielectric layer over the nitrided oxynitride layer.

USSN 09/941,827

Response

42. (original) The method of Claim 41, wherein the dielectric material comprises a high K dielectric.

43. (original) A method of forming a dielectric layer in a capacitor container comprising an opening formed in an insulative layer and a lower electrode comprising polysilicon formed within the opening, the method comprising the steps of:
forming an oxynitride layer over the lower electrode by annealing the electrode in the presence of nitric oxide;
nitridizing the oxynitride layer in a nitrogen-containing gas; and
forming a high K dielectric layer over the nitridized oxynitride layer.

44. (original) The method of Claim 43, wherein the step of annealing the lower electrode is at a temperature of about 700 to about 750°C.

45. (original) The method of Claim 43, further comprising annealing the dielectric layer in an oxidizing ambient.

46. (original) A method of forming a dielectric layer in a capacitor container comprising an opening formed in an insulative layer and a lower electrode comprising polysilicon formed within the opening, the method comprising the steps of:
forming an oxynitride layer over the lower electrode by annealing the electrode in the presence of nitric oxide;
nitridizing the oxynitride layer in an activated nitrogen-containing gas; and
forming a high K dielectric layer over the nitridized oxynitride layer.

47. (original) The method of Claim 46, wherein the step of annealing the lower electrode is at a temperature of about 700 to about 750°C.

48. (withdrawn) A method of forming a capacitor, comprising the steps of:

USSN.09/941,827

Response

forming a first capacitor electrode comprising polysilicon over a substrate;
forming an oxynitride layer over the first capacitor electrode by annealing the electrode in the presence of nitric oxide;
nitridizing the oxynitride layer in a nitrogen-containing gas; and
forming a dielectric layer over the oxynitride layer.

49. (withdrawn) The method of Claim 48, wherein the dielectric material comprises a high K dielectric.

50. (withdrawn) The method of Claim 49, wherein the dielectric material is selected from the group consisting of tantalum pentoxide, titanium dioxide, barium strontium titanate, strontium titanate, barium titanate, lead zirconium titanate, strontium bismuth tantalate, hafnium oxide, zirconium oxide, and aluminum oxide.

51. (withdrawn) The method of Claim 49, wherein the dielectric layer comprises tantalum pentoxide.

52. (withdrawn) The method of Claim 49, further comprising, after the step of forming the dielectric layer, annealing the dielectric layer in an oxidizing gas.

53. (withdrawn) A method of forming a capacitor, comprising the steps of:
forming a first capacitor electrode comprising polysilicon over a substrate;
forming an oxynitride layer over the first capacitor electrode by annealing the electrode in the presence of nitric oxide;
nitridizing the oxynitride layer in an activated nitrogen-containing gas; and
forming a dielectric layer over the oxynitride layer.

54. (withdrawn) A method of forming a capacitor, comprising the steps of:

USSN 09/941,827

Response

providing a substrate comprising an overlying insulative layer and a container opening formed in the insulating layer to an active area on the substrate, and a lower electrode comprising polysilicon formed within the container opening;

forming an oxynitride layer over the lower electrode by annealing the electrode in the presence of nitric oxide;

nitridizing the oxynitride layer in a nitrogen-containing gas;

forming a high K dielectric layer over the oxynitride layer; and

annealing the dielectric layer in an oxidizing gas.

55. (withdrawn) The method of Claim 54, wherein the step of forming the oxynitride layer comprises:

annealing the polysilicon electrode in the presence of nitric oxide at a temperature of less than 800°C. to form an oxynitride layer having a thickness about 40 angstroms or less.

56. (withdrawn) A method of forming a capacitor, comprising the steps of:

providing a substrate comprising an overlying insulative layer and a container opening formed in the insulating layer to an active area on the substrate, and a lower electrode comprising polysilicon formed within the container openings;

forming an oxynitride layer over the lower electrode by annealing the electrode in the presence of nitric oxide;

nitridizing the oxynitride layer in an activated nitrogen-containing gas;

forming a high K dielectric layer over the oxynitride layer; and

annealing the dielectric layer in an oxidizing gas.

57. (withdrawn) A method of forming a capacitor in a semiconductor device, comprising the steps of:

providing a substrate with an opening;

forming a first conductive electrode layer within the opening; the first electrode layer comprising hemispherical grain polysilicon;

USSN 09/941,827

Response

forming a thin layer of oxynitride over the first electrode layer by annealing the electrode in the presence of nitric oxide;

nitridizing the oxynitride layer in a nitrogen-containing gas;

forming an insulative layer over the oxynitride layer; the insulative layer comprising an insulating inorganic metal oxide material; and

forming a second conductive electrode layer over the insulative layer.

58. (withdrawn) The method of Claim 57, wherein the insulating inorganic metal oxide material comprises a high K dielectric.

59. (withdrawn) The method of Claim 58, wherein the insulating inorganic metal oxide material is selected from the group consisting of tantalum pentoxide, titanium dioxide, barium strontium titanate, strontium titanate, barium titanate, lead zirconium titanate, strontium bismuth tantalate, hafnium oxide, zirconium oxide, and aluminum oxide.

60. (withdrawn) The method of Claim 58, wherein the insulating inorganic metal oxide material comprises tantalum pentoxide.

61. (withdrawn) The method of Claim 57, further comprising, after the step of forming the insulating inorganic metal oxide material layer, annealing the layer in an oxidizing gas.

62. (withdrawn) The method of Claim 57, wherein the step of forming the oxynitride layer comprises:

annealing the polysilicon electrode in the presence of nitric oxide at a temperature of about 700 to about 750°C. to form an oxynitride layer having a thickness of about 40 angstroms or less.

Claims 63-77 (cancelled)

USSN 09/941,827

Response

78. (original) A method of forming a dielectric layer, comprising the steps of: thermally annealing a polysilicon substrate in nitric oxide to form an oxide layer; and annealing the oxide layer in a nitrogen gas to nitridize the oxide layer; wherein upon forming the dielectric layer over the nitridized oxide layer, and exposing the dielectric layer to an oxidizing gas, the nitridized oxide layer inhibits oxidation of the polysilicon substrate.

79. (original) A method of forming a dielectric layer, comprising the steps of: thermally annealing a polysilicon substrate in nitric oxide to form an oxide layer; annealing the oxide layer in a nitrogen gas to nitridize the oxide layer; and forming the dielectric layer over the nitridized oxide layer; wherein upon exposing the dielectric layer to an oxidizing gas, the nitridized oxide layer inhibits oxidation of the polysilicon substrate.

80. (original) A method of forming a dielectric layer, comprising the steps of: thermally annealing a polysilicon substrate in nitric oxide to form an oxide layer; annealing the oxide layer in a nitrogen gas to nitridize the oxide layer; forming the dielectric layer over the nitridized oxide layer; and exposing the dielectric layer to an oxidizing gas; whereupon the nitridized oxide layer inhibits oxidation of the polysilicon substrate.

81. (original) A method of forming a dielectric layer, comprising the steps of: thermally annealing a polysilicon substrate in nitric oxide to form an oxide layer; and plasma annealing the oxide layer in a nitrogen gas to form a layer of oxynitride; wherein upon forming the dielectric layer over the oxynitride layer, and exposing the dielectric layer to an oxidizing gas, the oxynitride layer inhibits oxidation of the polysilicon substrate.

82. (original) A method of forming a dielectric layer, comprising the steps of: thermally annealing a polysilicon substrate in nitric oxide to form an oxide layer;

USSN 09/941,827

Response

plasma annealing the oxide layer in a nitrogen gas to form a layer of oxynitride; and forming the dielectric layer over the oxynitride layer; wherein upon exposing the dielectric layer to an oxidizing gas, the oxynitride layer inhibits oxidation of the polysilicon substrate.

83. (currently amended) A method of forming a dielectric layer, comprising the steps of:

thermally annealing a polysilicon substrate in the presence of nitric oxide at a temperature of less than about 800°C[[.]] to form an oxide layer having a thickness of about 40 angstroms or less; and

annealing the oxide layer in a nitrogen gas to nitridize the oxide layer;

wherein upon forming a high K dielectric layer over the nitridized oxide layer, and exposing the dielectric layer to an oxidizing gas, the nitridized oxide layer inhibits oxidation of the polysilicon substrate.

84. (currently amended) A method of forming a dielectric layer, comprising the steps of:

thermally annealing a polysilicon substrate in the presence of nitric oxide at a temperature of less than about 800°C[[.]] to form an oxide layer having a thickness of about 40 angstroms or less;

annealing the oxide layer in a nitrogen gas to nitridize the oxide layer; and

forming a high K dielectric layer over the nitridized oxide layer;

wherein upon exposing the dielectric layer to an oxidizing gas, the nitridized oxide layer inhibits oxidation of the polysilicon substrate.

85. (currently amended) A method of forming a dielectric layer, comprising the steps of:

thermally annealing a polysilicon substrate in the presence of nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer having a thickness of about 40 angstroms or less;

USSN 09/941,827

Response

annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;
forming a high K dielectric layer over the nitridized oxynitride layer; and
annealing the dielectric layer in an oxidizing gas;
wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

86. (currently amended) A method of forming a dielectric layer, comprising the steps of:

thermally annealing a polysilicon substrate in the presence of nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer having a thickness of about 40 angstroms or less;

annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer; the nitrogen gas selected from the group consisting of nitrogen, ammonia, and nitrogen oxides;
forming a high K dielectric layer over the nitridized oxynitride layer; and
annealing the dielectric layer in an oxidizing gas;
wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

87. (currently amended) A method of forming a dielectric layer, comprising the steps of:

exposing a polysilicon substrate to nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer having a thickness of about 40 angstroms or less;
exposing the oxynitride layer to a plasma source of nitrogen to nitridize the oxynitride layer;

forming a high K dielectric layer over the nitridized oxynitride layer; and
exposing the dielectric layer in an oxidizing gas;
wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

88. (original) The method of Claim 87, wherein the plasma source of nitrogen comprises a nitrogen gas selected from the group consisting of nitrogen, ammonia, a mixture of nitrogen and helium, a mixture of nitrogen and argon, and nitrogen oxides.

USSN 09/941,827

Response

89. (currently amended) A method of forming a dielectric layer, comprising the steps of:

thermally annealing a polysilicon substrate in the presence of nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer having a thickness of less than about 15 angstroms;

annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer; and forming a high K dielectric layer over the nitridized oxynitride layer;

wherein upon exposing the dielectric layer to an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

90. (currently amended) A method of forming a dielectric layer, comprising the steps of:

thermally annealing a polysilicon substrate in the presence of nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer having a thickness of less than about 15 angstroms;

annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;

forming a high K dielectric layer over the nitridized oxynitride layer; and

annealing the dielectric layer in an oxidizing gas;

wherein the nitridized oxynitride layer inhibits oxygen diffusion into the polysilicon layer.

91. (currently amended) A method of forming a dielectric layer, comprising the steps of:

exposing a polysilicon substrate to nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer; and

exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;

wherein upon forming the dielectric layer over the nitridized oxynitride layer, and exposing the dielectric layer to an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

USSN 09/941,827

Response

92. (currently amended) A method of forming a dielectric layer, comprising the steps of:

exposing a polysilicon substrate to nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer;
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer; and
forming the dielectric layer over the nitridized oxynitride layer;
wherein upon exposing the dielectric layer to an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

93. (currently amended) A method of forming a dielectric layer, comprising the steps of:

exposing a polysilicon substrate to nitric oxide ~~oxide~~ at a temperature of less than about 800°C[[.]] to form an oxynitride layer;
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;
forming the dielectric layer over the nitridized oxynitride layer; and
exposing the dielectric layer to an oxidizing gas;
wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

94. (currently amended) A method of forming a dielectric layer, comprising the steps of:

exposing a polysilicon substrate to nitric oxide at a temperature of less than about 800°C[[.]] to form an oxynitride layer having a thickness of less than about 40 angstroms; and
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;
wherein upon forming a high K dielectric layer over the nitridized oxynitride layer; and
exposing the dielectric layer to an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon substrate.

USSN 09/941,827

Response

95. (withdrawn) A method of forming a dielectric layer in a capacitor container, the capacitor container comprising an opening in an insulative layer and a conductive polysilicon lower electrode disposed within the opening, the method comprising the steps of:

exposing the polysilicon lower electrode to nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer having a thickness of less than about 15 angstroms;
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;
forming a high K dielectric layer over the nitridized oxynitride layer; and
exposing the dielectric layer to an oxidizing gas;
wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon lower electrode.

96. (withdrawn) A method of forming a capacitor, comprising the steps of:
forming a first electrode over a substrate, the first electrode comprising polysilicon;
exposing the polysilicon electrode to nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less; and
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;
wherein upon forming a high K dielectric layer over the nitridized oxynitride layer, and
exposing the dielectric layer to an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode.

97. (withdrawn) A method of forming a capacitor, comprising the steps of:
forming a first electrode over a substrate, the first electrode comprising polysilicon;
exposing the polysilicon electrode to nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less;
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;
forming a high K dielectric layer over the nitridized oxynitride layer; and
exposing the dielectric layer to an oxidizing gas;
wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode.

USSN 09/941,827

Response

98. (withdrawn) A method of forming a capacitor, comprising the steps of:
forming a first electrode over a substrate, the first electrode comprising polysilicon;
thermally annealing the polysilicon electrode in the presence of nitric oxide at a
temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of
less than about 15 angstroms; and
annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;
wherein upon forming a high K dielectric layer over the nitridized oxynitride layer, and
annealing the dielectric layer in an oxidizing gas, the nitridized oxynitride layer inhibits
oxidation of the polysilicon electrode.
99. (withdrawn) A method of forming a capacitor, comprising the steps of:
forming a first electrode over a substrate, the first electrode comprising polysilicon;
thermally annealing the polysilicon electrode in the presence of nitric oxide at a
temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of
less than about 15 angstroms;
annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;
forming a high K dielectric layer over the nitridized oxynitride layer; and
annealing the dielectric layer in an oxidizing gas,
wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode.
100. (withdrawn) The method of Claim 99, further comprising the step of forming a
second electrode over the dielectric layer, the second electrode comprising a conductive material.
101. (withdrawn) The method of Claim 99, wherein the first electrode comprises HSG
polysilicon.
102. (withdrawn) The method of Claim 100, wherein the second electrode comprises a
conductive polysilicon or a conductive metal.

USSN 09/941,827

Response

103. (withdrawn) The method of Claim 102, wherein the second electrode comprises a conductive metal selected from the group consisting of tungsten, tungsten nitride, titanium nitride, and platinum.

104. (withdrawn) The method of Claim 100, wherein the step of forming the second electrode comprises depositing the conductive material by chemical vapor deposition or physical vapor deposition.

105. (withdrawn) A method of forming a capacitor, comprising the steps of:
providing a substrate comprising an insulative layer disposed thereon and one or more openings in the insulative layer extending to the substrate, and a first electrode disposed over the substrate within the one or more openings, the first electrode comprising polysilicon;
exposing the polysilicon electrode to nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less; and
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;
wherein upon forming a high K dielectric layer over the nitridized oxynitride layer, and exposing the dielectric layer to an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode.

106. (withdrawn) A method of forming a capacitor, comprising the steps of:
providing a substrate comprising an insulative layer disposed thereon and one or more openings in the insulative layer extending to the substrate, and a first electrode disposed over the substrate within the one or more openings, the first electrode comprising polysilicon;
thermally annealing the polysilicon electrode in the presence of nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less; and
annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;
wherein upon forming a high K dielectric layer over the nitridized oxynitride layer, and annealing the dielectric layer in an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode.

MAD/I12351.1

20 of 30

USSN 09/941,827

Response

107. (withdrawn) A method of forming a capacitor, comprising the steps of:
providing a substrate comprising an insulative layer disposed thereon and one or more openings in the insulative layer extending to the substrate, and a first electrode disposed over the substrate within the one or more openings, the first electrode comprising polysilicon;
thermally annealing the polysilicon electrode in the presence of nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less;
annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;
forming a high K dielectric layer over the nitridized oxynitride layer;
annealing the dielectric layer in an oxidizing gas, wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode; and
forming a second electrode over the dielectric layer, the second electrode comprising a conductive material.

108. (withdrawn) A method of forming a capacitor, comprising the steps of:
providing a substrate comprising an insulative layer disposed thereon and one or more openings in the insulative layer extending to the substrate;
forming a first electrode over the substrate within the one or more openings, the first electrode comprising polysilicon;
exposing the polysilicon electrode to nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less; and
exposing the oxynitride layer to a nitrogen gas to nitridize the oxynitride layer;
wherein upon forming a high K dielectric layer over the nitridized oxynitride layer, and exposing the dielectric layer to an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode.

109. (withdrawn) A method of forming a capacitor, comprising the steps of:
providing a substrate comprising an insulative layer disposed thereon and one or more openings in the insulative layer extending to the substrate;

USSN 09/941,827

Response

forming a first electrode over the substrate within the one or more openings, the first electrode comprising polysilicon;

thermally annealing the polysilicon electrode in the presence of nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less; and

annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;

wherein upon forming a high K dielectric layer over the nitridized oxynitride layer, and annealing the dielectric layer in an oxidizing gas, the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode.

110. (withdrawn) A method of forming a capacitor, comprising the steps of:

providing a substrate comprising an insulative layer disposed thereon and one or more openings in the insulative layer extending to the substrate;

forming a first electrode over the substrate within the one or more openings, the first electrode comprising polysilicon;

thermally annealing the polysilicon electrode in the presence of nitric oxide at a temperature of less than about 800°C. to form an oxynitride layer thereon having a thickness of about 40 angstroms or less;

annealing the oxynitride layer in a nitrogen gas to nitridize the oxynitride layer;

forming a high K dielectric layer over the nitridized oxynitride layer;

annealing the dielectric layer in an oxidizing gas, wherein the nitridized oxynitride layer inhibits oxidation of the polysilicon electrode; and

forming a second electrode over the dielectric layer, the second electrode comprising a conductive material.

111. (previously presented) The method of Claim 2, wherein the step of nitridizing the oxynitride layer comprises exposing the oxynitride layer to a nitrogen-containing gas.

USSN 09/941,827

Response

112. (previously presented) The method of Claim 111, wherein the nitrogen-containing gas is selected from the group consisting of nitrogen, ammonia, nitrous oxide, and nitric oxide.

113. (previously presented) The method of Claim 111, wherein the nitrogen-containing gas comprises a plasma nitrogen.

114. (currently amended) The method of Claim 2, wherein the step of nitridizing the oxynitride layer is at a temperature of up to about 900°C[.].

115. (previously presented) The method of Claim 2, wherein the oxynitride layer and nitride layer have a combined thickness of about 10 to about 40 angstroms.

116. (previously presented) The method of Claim 2, wherein the dielectric layer comprises a high K dielectric.

117. (previously presented) The method of Claim 116, wherein the dielectric layer comprises a high K dielectric selected from the group consisting of tantalum pentoxide, titanium dioxide, barium strontium titanate, strontium titanate, barium titanate, lead zirconium titanate, strontium bismuth tantalate, hafnium oxide, zirconium oxide, and aluminum oxide.

118. (previously presented) The method of Claim 116, wherein the dielectric layer comprises tantalum pentoxide.

119. (previously presented) The method of Claim 2, further comprising, after the step of depositing the dielectric layer, annealing the dielectric layer in an oxidizing gas.

120. (previously presented) The method of Claim 119, wherein the oxidizing gas is selected from the group consisting of oxygen, plasma oxygen, ozone, nitrous oxide, and mixtures thereof.

MAD/112351.1

23 of 30

USSN 09/941,827

Response

121. (previously presented) The method of Claim 119, wherein the oxidizing gas comprises a plasma oxygen.

122. (previously presented) The method of Claim 119, wherein the oxynitride layer has a thickness that is substantially the same before and after the step of annealing the dielectric layer.

123. (previously presented) The method of Claim 2, wherein the step of nitridizing the oxynitride layer comprises exposing the oxynitride layer to an activated nitrogen-containing gas.

124. (previously presented) The method of Claim 2, wherein the polysilicon substrate comprises HSG polysilicon.

125. (previously presented) The method of Claim 2, wherein the dielectric layer is formed on a semiconductor substrate.

126. (previously presented) The method of Claim 2, wherein the dielectric layer is formed over a polysilicon layer disposed within an opening in an insulative layer.

127. (previously presented) The method of Claim 2, further comprising, prior to the step of annealing the polysilicon substrate, the steps of forming an opening in an insulative layer, and forming a layer of the polysilicon within the opening.

128. (previously presented) The method of Claim 2, further comprising, prior to the step of annealing the polysilicon substrate, the steps of forming the polysilicon substrate over a substrate.

129. (previously presented) The method of Claim 128, wherein the polysilicon substrate comprises a capacitor electrode.

MAD/112351.1

24 of 30

USSN 09/941,827

Response

130. (previously presented) The method of Claim 2, further comprising, prior to the step of annealing the polysilicon substrate, the step of providing a substrate comprising an overlying insulative layer, an opening formed in the insulating layer, and a layer of polysilicon formed within the opening.

131. (previously presented) The method of Claim 2, further comprising, prior to the step of annealing the polysilicon substrate, the step of providing a substrate comprising an insulative layer disposed thereon and one or more openings in the insulative layer extending to the substrate, and a layer of the polysilicon substrate disposed over the substrate within the one or more openings.

132. (previously presented) The method of Claim 2, further comprising, prior to the step of annealing the polysilicon substrate, the steps of providing a substrate comprising an opening, and forming a first conductive electrode layer within the opening; the first electrode layer comprising hemispherical grain polysilicon.

133. (previously presented) The method of Claim 132, further comprising the step of forming a second conductive electrode layer over the dielectric layer.

134. (previously presented) The method of Claim 133, wherein the second electrode comprises a conductive material.

135. (previously presented) The method of Claim 134, wherein the second electrode comprises a conductive polysilicon or a conductive metal.

136. (previously presented) The method of Claim 134, wherein the second electrode comprises a conductive metal selected from the group consisting of tungsten, tungsten nitride, titanium nitride, and platinum.

USSN 09/941,827

Response

137. (previously presented) The method of Claim 135, wherein the step of forming the second electrode comprises depositing the conductive material by chemical vapor deposition or physical vapor deposition.

138. (previously presented) The method of Claim 2, wherein the dielectric layer comprises an insulating inorganic metal oxide material.

139. (previously presented) The method of Claim 136, wherein the dielectric layer comprises a high K dielectric.

140. (previously presented) The method of Claim 2, wherein the step of annealing comprises thermally annealing the polysilicon substrate.

141. (previously presented) The method of Claim 2, wherein the step of nitridizing the oxynitride layer comprises annealing the oxynitride layer in a nitrogen gas.

142. (previously presented) The method of Claim 2, wherein the step of nitridizing the oxynitride layer comprises plasma annealing the oxynitride layer in a nitrogen gas.

143. (previously presented) The method of Claim 2, wherein the step of nitridizing the oxynitride layer comprises exposing the oxynitride layer to a plasma source of nitrogen.

144. (previously presented) The method of Claim 143, wherein the plasma source of nitrogen comprises a nitrogen gas selected from the group consisting of nitrogen, ammonia, a mixture of nitrogen and helium, a mixture of nitrogen and argon, and nitrogen oxides.

145. (previously presented) The method of Claim 2, wherein the step of annealing forms an oxynitride layer having a thickness of about 40 angstroms or less.

USSN 09/941,827

Response

146. (previously presented) The method of Claim 2, wherein the step of annealing forms an oxynitride layer having a thickness of less than about 15 angstroms.

147. (previously presented) The method of Claim 2, wherein the nitridized oxynitride layer is effective to inhibit oxidation of the polysilicon substrate.

148. (currently amended) A method of forming a dielectric layer, comprising the steps of:
annealing a polysilicon substrate in nitric oxide at a temperature of less than 800°C[.];
nitridizing the annealed polysilicon layer to form a silicon nitride layer; and
depositing the dielectric layer onto the silicon nitride layer.

149. (currently amended) A method of forming a dielectric layer, comprising the steps of:
annealing a polysilicon substrate in nitric oxide at a temperature of less than 800°C[.];
nitridizing the annealed polysilicon layer to form a silicon nitride layer;
depositing the dielectric layer onto the silicon nitride layer; and
exposing the dielectric layer to an oxidizing gas, wherein oxidation of the polysilicon layer is inhibited.

150. (new) The method of Claim 2, wherein the nitride layer is about 5 to about 15 angstroms thick.

151. (new) The method of Claim 2, wherein the oxynitride layer and the nitride layer have a combined thickness of about 10 to about 30 angstroms.

152. (new) The method of Claim 2, wherein the step of nitridizing comprises exposing the oxynitride layer to a remote plasma source of nitrogen.

*USSN 09/941,827**Response*

153. (new) The method of Claim 2, further comprising saturating the dielectric layer with oxygen.

154. (new) The method of Claim 153, wherein the step of saturating comprises subjecting the dielectric layer to an anneal in the presence of an oxidizing gas.

155. (new) The method of Claim 154, wherein the oxygen anneal comprises annealing with one or more of oxygen, plasma oxygen, ozone, and nitrous oxide.

156. (new) The method of Claim 2, further comprising depositing a conductive material over the dielectric layer.

157. (new) The method of Claim 156, wherein the conductive material is selected from the group consisting of doped polysilicon, tungsten, tungsten nitride, titanium nitride, and platinum.